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ABSTRACT

This issue of the American Association for the Advancement of Science (AAAS) newsletter is devoted to the science education for physically, visually, and aurally handicapped children. Articles include thoughts on teaching deaf students and blind students, a brief description of a science program for young physically handicapped children, aids in teaching laboratory science to visually impaired students and deaf students, aids in teaching field aspects of science to the physically handicapped, and counseling of the handicapped for a career in science. A collection of addresses of organizations and sources of information for teachers who have handicapped students in their classes is included. (MA)

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Science Education News

American Association for the Advancement of Science

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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Fall 1978/Winter 1979

Science Education and the Physically Handicapped

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From kindergarten through college the teaching community in general and the science teaching community in particular are caught in a dilemma with respect to educating handicapped students. As a result of the regulations of Section 504 of the 1973 "Rehabilitation Act" and P.L. 94-142 "The Education for All Handicapped Children Act," educators, on the one hand, must respond to a host of new regulations and requirements with the actions necessary to educate the handicapped in the least restrictive alternative. On the other, they must face and deal with virtually no increase in funding and with little or no teacher preparation or support in educating handicapped students in a mainstream setting. With the emphasis of legislative activities at all levels to lower taxes, this dilemma has raised frustration and concern among science and other teachers throughout the country.

Two recent conferences have dealt with the problems of the handicapped in science, and it is the consensus of these conferences that although the architectural barriers to education are the most evident they are the barriers easiest to alleviate.[1,2] Attitudinally related barriers are by far more difficult to remove. The participants in these conferences recommended that science education for the handicapped should include career information and specific adaptive teaching materials, along with science teacher education in facilitating the educational process for handicapped students. Evaluation and documentation of technologies and practices for teaching science to handicapped students are urgently needed. The lack of dissemination of findings on the science education of the physically handicapped has been a major problem. In this regard, this special issue of *Science Education News* is a step in the right direction.

This issue of *Science Education News* is the first devoted to a single important topic since April 1977 when "Back to Basics" was presented as a special issue. One might suggest that the title of this issue be "Back to Integration," but this time it is the physically handicapped who seek and will, it is hoped, receive equality. It is our intent herein to provide helpful opinions and ideas, as well as understanding of the unique (but not-too-difficult-to-supply) needs of sensory- and mobility-handicapped students in their education in science. We include papers in four general areas: learning, curriculum, aids in teaching, and careers and counseling. It is not intended that this issue be in any way comprehensive, but only to present a sampling of ideas and concepts organized around these four general topics. The views expressed by the authors are not necessarily consistent with ours, nor do some agree among themselves. However, they offer a representative sampling of some contemporary views on education of handicapped individuals in science. It is in that light that we offer them to you.—E. C. KELLER, JR., *Department of Biology, West Virginia University, Morgantown, WV 26506,* and MARTHA R. REDDEN and CHERYL A. DAVIS, *Office of Opportunities in Science, AAAS.*

Deafness and Learning

Deafness imposes a communication barrier which impedes a person's ability to take a rightful place in the hearing world. The effects of the communication barrier may be profound and yet they can be overcome. By becoming familiar with common specific problems and developing appropriate solutions, deaf students can achieve along with their hearing peers. The following discussion describes the principal problems and outlines some accommodations by which deaf and hearing-impaired children may learn effectively.

In a school situation, deaf students cannot write or read while simultaneously receiving spoken information, since they use a single sense—the visual—to do both. Students' attention must shift from the visual requirements of reading or writing to visual perception of oral language (lipreading, signing, finger spelling), accompanied by such auditory cues as a hearing aid may provide. Where ambient noise is not controllable, a hearing aid, if used, may also provide unwanted distraction or distortion. Since it is not possible for a deaf student to "hear" a lecture or to receive oral directions and take notes simultaneously, deaf students who are integrated in hearing classes require notetakers and usually an interpreter. The interpreter transmits the

[1] A Working Conference on Science Education for Handicapped Students, sponsored by the National Science Teachers Association, 3-5 April 1978, Arlington, VA.

[2] Barriers to Science Education for Handicapped Students at the Postsecondary Level, sponsored by AAAS, 9-11 June 1978, Arlington, VA.

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teacher's lecture directly, either through manual communication (signing and finger spelling) or through lipreading. In either case a prior presentation of new vocabulary may be required by the hearing-impaired student, especially if the new vocabulary is highly specialized. Deaf students profit from related reading introducing them to the context, new vocabulary, and concepts prior to classroom lecture, or an advance précis of a laboratory demonstration, since one cannot simultaneously lipread the instructor and observe or participate actively in the demonstration.

Since reading is related directly to language input and storage,[1] it is understandable that the reading level of many—but not all—students is from two to four years below that of their hearing peers. This has absolutely no reflection upon the intelligence of a deaf student. It does not indicate an intellectual limitation. However, it causes a number of students difficulty with some standard texts. It is important to remember that their problem is not with the concepts, but with the language used to present them. Still, a lower reading level compounds the learning problem because the prime mode for the hearing impaired to receive information most rapidly and accurately is reading. Errors in perception can be corrected more immediately by this mode than by any other. Programmed or computer-assisted instruction and other mediated presentations[2] permit individualized learning experiences to be accessible to deaf students with a minimal need of assistance, provided that the deaf student has sufficient reading skill and language competency to interact with the materials. It is essential that hearing-impaired students be provided with an effective remedial language and reading program when early education has not permitted acquisition of skills appropriate to their intellectual potential.

For deaf students the significant difference between nonverbal and verbal scores on standard tests of intelligence is a function of language levels and testing modes. This difference may be reduced as students' linguistic competencies and resultant conceptual development and cognitive processing skills improve. The precision of written output and its accessibility to deaf students for self correction and monitoring through the visual feedback loop makes it the best evaluative performance mode for the classroom.

The deaf student with good speech or who uses reverse interpretation (the interpreter translating the student's speech and/or manual communication for the teacher and class) may participate profitably in classroom discussion. This feedback not only brings the student into the group learning process, but also permits social-emotional-cognitive interaction with the deaf student's peers. Speech competencies are developed by the congenitally deaf, or are maintained in the case of acquired deafness, only with constant effort. The speech of deaf youth and adults may vary from full intelligibility to minimal. Understanding voice quality and articulation is enhanced by and may often require familiarity with the speaker on the part of the listener. We comprehend the speech of those we know best more readily than the speech of strangers when heard over the telephone or under noisy conditions which affect intelligibility.

The integration of deaf students in hearing classes obviously requires the provision of support services to the students and to the families (interpreter, tutor, speech and hearing specialists, notetaker) in addition to counseling and early access to career education. The tendency expressed by other minority students to feel isolated, to lack role models, and to fail to develop realistic goals is exacerbated for the deaf by the problems related to language input and output. Frequently the school gives the deaf youth and his family a low expectation level reinforcing the tendency to low self-concept and poor motivation, thus perpetuating a self-defeating cycle. The National Technical Institute for the Deaf in which deaf and hearing students live and learn together in dormitories, classrooms, and laboratories while preparing for scientific and technical careers provides evidence of the effectiveness of well-supported, integrated educational opportunities at the two- and four-year college level. The movement toward integrated learning experiences at the secondary level is accelerating under the impetus of P.L. 94-142 and sections of the 1973 Rehabilitation Act. At secondary school and community college levels, a wide variety of options for the deaf have been developed. These range from regional special school programs[3] to special classes within regular school programs, with varying degrees of integration and remedial instruction, to full integration[4] in local schools and colleges with the provision of a battery of supportive services.

Deafness need not impose an insurmountable barrier to full educational opportunity. Increased understanding of language, cognitive processing, and communicative problems along with the provision of individualized supplemental services at an early age bode well for improved educational options. The provision of support services, remedial and tutorial instruction in the least isolated and restrictive environment provides viable alternatives to permit deaf students to prepare themselves for professional and vocational goals, in any field, commensurate with their potential.—HARRIET G. KOPP, *Department of Communicative Disorders, San Diego State University, San Diego, CA 92182.*

[1] Harriet G. Kopp, Editor, "Curriculum, Cognition and Content," *Volta Review*, vol. 70, no. 6, September 1968.

[2] Harriet G. Kopp, "Applications of Systems Concepts to Teaching the Deaf," *American Annals of the Deaf*, vol. 8, pp. 668-677, 1966.

[3] Model Secondary School for the Deaf, Gallaudet College, Washington, D.C.

[4] National Technical Institute for the Deaf, Rochester, New York.

Some Thoughts on Education of the Blind

A few hundred years ago blind people were regarded as public curiosities—objects of ridicule. As the centuries went by, the blind came to be regarded with pity. Care and kindness replaced overt rejection. This, how-

ever, was not the status of citizenship, but rather of dependent or ward.

Today, the blind themselves, through their own nationwide organizations, are teaching the public at large a new and more positive image of blindness, and they are leading the way to full integration. Largely through their own efforts and through their strong sense of organization for self-expression, thousands of blind people have entered full-time competitive employment and have taken on all the tasks of useful citizenship in their communities.

The schools must be a part of this new approach as they accept young blind students who wish to be more than objects of pity. The regular public or parochial schools can do this in a particularly effective manner, but residential schools always face the problem of isolation from the world at large. Merely enrolling youngsters and placing them in seats within regular classrooms, however, assures nothing. If they are led about by their classmates, protected by their teachers, and given high grades for the smallest accomplishments, they will still be nothing more than objects of charity and pity.

When the classroom teacher learns that a blind student will be enrolling, a typical reaction is to wonder how to manage without neglecting the other boys and girls, assuming that the blind student's needs will deprive the sighted peers. In fact, the blind student will *not* require a disproportionate amount of time and can be expected to be well adjusted and independent. Teachers of today expect to work with individual differences, such as gifted students who need extra challenges or ethnically mixed classes that need guidance in human relations. Blind students may be seen as another example of individual differences; and viewing them in this perspective is an important step toward good adjustment.

Blind youngsters should follow the regular curriculum of their schools, on a level with their individual academic abilities. They should not need to repeat grades, use easier books, or otherwise achieve less due to blindness *per se*.

Many people who consider themselves "partially sighted" function more effectively by using alternative techniques (methods usable by the totally blind). Partially sighted students should be taught to avoid a common and very serious error: relying on partial sight in a situation where an alternative technique would be more efficient, effective, or safe. The technique should be responsive to the need, rather than be based on a rigid commitment to use of sight in situations where this may be inappropriate.

The most serious problem of blindness is not the physical lack of sight, but public attitudes. Sighted people tend to do far too much for blind persons, who in turn tend to accept this and encourage a vicious circle of dependency. The best thing that educators can do for blind students is to convince them that they can and should lead full, normal, independent lives. The most important factors for the successful placement of blind students in schools are (1) understanding that these are *normal* boys and girls who have the same needs as other youngsters and who happen to be blind; (2) expectation of success; and (3) flexibility and imagination.

The blind student's self-image is extremely important. By avoiding or counteracting negative influences and by promoting positive influences, educators can be of great help in building the image of the normal, competent blind person.

Some say that blind persons should learn an attitude of dependence, since they must frequently depend on others. This is false and inappropriate for many reasons. There is always a way to achieve any important goal; and if sighted assistance is involved for some particular task, the blind person will expect to reciprocate appropriately rather than to accept help passively. Furthermore, we are *all* interdependent, and the competent blind person is no more so than others.

In science, the teacher may be especially tempted to assume that a blind student cannot adequately participate. The fear for a blind student's safety should not realistically exceed that which a teacher has for any student's safety. It should never prevent the student's participation. Moreover, excessive fear on the teacher's part can deprive a blind student of the willingness to broaden his or her range of experience and skills. The loss of that willingness is in many ways an impairment more serious than the loss of sight.

Blind students should be taught to develop realistic views of themselves and their goals. They should not expect to do everything perfectly—after all, who does? However, educators should avoid the error of regarding every accomplishment as "wonderful," even when it is something as routine as finding a doorway. (Note: Of course, if a student has been having trouble with a routine task, we will compliment him when he does achieve success. However, there is a vast difference between "Good! I knew you could do it!" and "What a *marvelous* job! I'm sure I could never do as well!").

Blindess must never be used as an excuse for poor performance. School staff will want to help students avoid "taking advantage" by expecting too much help or special consideration, playing one adult against another, or assuming that all their problems are due to blindness.

There is no formula to guarantee that *any* person will succeed in school or in life. However, with ingenuity and a positive attitude, educators can help blind students to work toward their own success.—DORIS WILLOUGHBY, *Education Specialist, National Federation of the Blind, 1346 Connecticut Avenue, N.W., Washington, D.C. 20036.*

A Program to Teach Science to Young Physically Handicapped Children

Science education is a powerful vehicle for promoting cognitive and intellectual development in children, transforming human values, and enabling the young to fulfill their human potential. Sadly, it has not played a vital role in the academic, social, and emotional development of most handicapped children, who have largely been deprived of an ability to appreciate the order, meaning,

and beauty of their environment. It is unfortunate that the sense of wonder has not been encouraged in these children through science, which motivates learning for handicapped and nonhandicapped students alike.

Too often, handicapped elementary school children experience school as painfully frustrating. Classroom teachers frequently view them simply as problems, finding them difficult to teach and manage, extra burdens with which they must somehow cope. In a program that has continued for six years at the Horace Mann Elementary School in Washington, D.C., however, handicapped and nonhandicapped children work successfully side-by-side, partners in discovery and creativity. They are motivated to read, explore, listen, and seek truth—using materials and teaching strategies adapted to their needs. Through individualized experiences, they have an opportunity to experiment and observe using their available senses. The experiential science approach becomes not only a means of promoting intellectual development, but also of building in children a sense of competence through actual hands-on experience.

In the program at Horace Mann, scientific principles are studied through artistic experiences. Working within the medium of art, the students gain information about natural phenomena through the process of creation. Four curricula have been developed through the program treating the subjects of science and art for blind and other children with special needs.

For the past six years, we have seen handicapped children enter our science laboratory and watched the "handicap" actually disappear! When the appropriate adaptations have been made, the "handicapped" child is no more handicapped than the "normal" one. Both handicapped and nonhandicapped children in the program find learning exciting and extremely rewarding. By giving the pupils the autonomy to conduct their own explorations and investigations in laboratory science, they gain self-confidence and self-esteem, live more comfortably with their world and within themselves, and flower as individuals within the warm light of wonder.—DORIS HADARY, *Department of Chemistry, American University, Washington, D.C. 20016.*

On Teaching the Blind Student

Three qualities should characterize the accommodation of the handicapped in public education: common sense, flexibility, and equal treatment. A change in attitude can accomplish much toward successful accommodation, and with a minimum of expense in time, money, and effort.

Everyone's perception of a problem is influenced by one's own experience. Mine is that of a totally blind scientist. I teach and conduct research at the undergraduate and graduate levels in the zoology department of a large public Eastern university. My research consists of field and museum work on the ecology, evolution, geometry, and adaptations of snails and other shelled animals of the oceans of the world. My comments about education of the handicapped are the opinions of one who was motivated to work hard in school.

Education has two basic functions. First, it conveys knowledge and skills that enable us to deal with life, pay our taxes, and hold a job. This function encompasses specific training not only in reading, writing and calculating, but also in thinking, analyzing, asking questions, and applying knowledge. Second, education instills values that permit us to live and function in the society in which we grow up. This is the function of integration.

Many people believe that for the blind and for other handicapped individuals, the two functions of education are incompatible. Educators who run residential schools often maintain that blind students cannot learn essentials like Braille and independent travel adequately unless they are segregated in special schools or classrooms. On the other hand, residential schools prevent blind students from being integrated into society at large until they go to college or get jobs. Public education, however, is a ready vehicle for social integration. Moreover, public schools can and do teach special skills to the blind. Training in Braille, typing, mobility, and other techniques essential to the functioning of a blind individual can supplement the standard curriculum or replace parts of it.

My experiences in the public schools of New Jersey prove that training and integration can coexist in the standard classroom. Once or twice a week, an excellent resource teacher from the New Jersey State Commission for the Blind came to teach me English grammar, contracted English Braille, Braille typewriting, and standard typing. Throughout my public education, the Commission provided textbooks that had been brailled by volunteers. From eighth grade on, a reader paid by the state came daily to read other books for leisure, and a Commission instructor gave me mobility training.

The residential schools in the Netherlands had already trained me thoroughly in Braille. One of these schools also had a small collection of stuffed animals. These specimens fascinated me and helped sustain my interest in natural history. The school frequently took me and my classmates on excursions to woods, heaths, beaches, airports, and other places, where all of us were at liberty to experience firsthand the world around us.

These elements of education must be incorporated into the curriculum of both blind and sighted students. The first few years of schooling of the blind must include a thorough training in reading, writing, mobility, and exploration.

Not all exploration can be done firsthand, of course. Thus it is essential to acquaint blind students, like sighted students, with the world around them by means of illustrations, other sensory aids, and books.

Educators of the blind have generally been reluctant about using tactile illustrations with the blind. Part of this conservatism stems from the belief that the blind cannot comprehend or interpret raised-line drawings. Moreover, many educators consider such illustrations to be difficult and expensive to make.

Both contentions are wrong or at least misleading. If a blind person's tactile perception is good enough to permit Braille reading, it is probably good enough to deal with tactile illustrations. Blind children may need

some training in making and interpreting drawings, as do most sighted children, but the result is well worth the effort. At least three methods of making tactile illustrations show the common sense I think is needed in accommodating the blind.

The simplest method requires a pen and pencil and a standard-sized sheet of paper. The illustrator lays a piece of paper on a slightly yielding surface (a stack of papers, a sheet of rubber, a piece of cloth) and firmly draws the illustration with the point of a pen or pencil. The raised-line drawing that is produced on the opposite side of the paper is a mirror image of the original drawing, and it consists of smooth lines that any perceptive blind person can feel easily.

Many of my professors in college used this technique to good advantage. It would take them a minute or two to prepare a graph or other representation to which I could refer during the lecture.

One of my teachers in the Netherlands developed a method of making illustrations that is slightly more complex but equally inexpensive. The illustrator pegs or tapes a piece of fine metal screen to a hard board, lays a sheet of Braille paper on the screen, and draws a stylus or other sharp point across the sheet. This method requires slightly more time and talent than does the use of pencil and paper, but it has two advantages. The mirror-image drawing that appears on the opposite side of the paper consists of very clear lines, and the illustrator can regulate the intensity and texture of the lines.

Nancy Amick, at the Princeton, New Jersey, unit of Recording for the Blind, has developed a third method. She makes a complex illustration by drawing with points of various shapes and sizes on heavy aluminum foil. She then can use the thermoform process to duplicate the resulting mirror-image master on plastic sheets. Using this method, Ms. Amick made me a series of biological illustrations and geological maps which are both esthetically pleasing and highly accurate. Her method requires considerable time and talent, but is highly effective and still fairly inexpensive.

These methods are examples of what I call commonsense accommodation of the handicapped. They cost little money and require no technical equipment. The simpler ones call for very little specialized talent and a trivial investment in time. The methods have the great additional benefit of permitting the blind to make their own drawings. Thus they have occasion to use their own imaginations and to apply actively what they have observed previously.

The science laboratory provides an example of flexibility. There are certain procedures and types of experiments that a blind person cannot do in the laboratory with present-day technology. Inability to do some of the laboratory work does not, however, excuse a blind student from doing calculations or from experiencing the techniques secondhand through classmates' descriptions.

Moreover, a blind student can easily use many laboratory techniques: some dissections and examination of plants and animals, many experiments in mechanics and electricity, measurements of length and angles. In addition, the department can buy models designed to acquaint the student with phenomena or things that cannot be experienced firsthand. From the viewpoint of the blind student, it is much better to take a course in which some of the laboratory work cannot be done firsthand than to be denied the opportunity to take the course.

This does not mean that the criteria used in evaluating a blind student should be different from those for a sighted student. It is unfair either to relax criteria for the blind or to invent additional ones. Thus, we should not permit a student to complete a course without some understanding of techniques—nor should we demand medical information or psychological tests if these are not also required of other students. Blind and other handicapped people desire equal, not preferential or different, treatment. To compete with the sighted on uneven terms severely weakens the position of the blind and impairs their chances of changing people's attitudes and of achieving integration.

I wish to emphasize that many problems which the handicapped face are those of the human population as a whole. Neither the blind nor the sighted will learn science or any other subject unless they are motivated, and unless teachers portray their subjects as fun, exciting, powerful, and intellectually satisfying. Teachers who discourage the blind from taking a particular course or pursuing a field probably discourage nonhandicapped students as well. A flexible, tolerant attitude that encourages experimentation and a little risk helps lower educational barriers for blind and sighted alike.—GEERAT J. VERMEIJ, *Associate Professor of Zoology, University of Maryland, College Park, MD 20742.* [Adapted from *Today's Education,* November-December 1978.]

Itinerant Teaching

An expression so old as to have become almost a cliché in special education is, "Special education is an island within regular education." The impact of P.L. 94-142 upon the schools appears to make that philosophy of historical value only. For regular education the critical portion of P.L. 94-142 is the provision that the exceptional child must be provided with a free and appropriate education within the "least restrictive environment," defined very specifically as a hierarchy of possible administrative placements, with regular class placement being the most desirable and special school placement being the least desirable. For each exceptional child every effort should be made to provide the same educational experiences available to all children and, in addition, the experiences appropriate for his or her special needs. The old cliché has been reversed; the philosophy must now be "Regular education is an island within special education." The concern of special educators now is to develop administrative procedures to deliver the special educational experiences which are appropriate for each child's special needs while the child has all the benefits of regular education.

Several delivery systems have been developed; each offering a different degree of mainstreamed learning experience. The child may be enrolled in a regular class

and attend a resource room for part of the day for instruction by a specially trained teacher; the child may be enrolled in a special, cooperative classroom and attend the regular classroom for needs shared with other children; or the child may be enrolled in a regular class most of the school day with special needs being met by an itinerant teacher or teacher consultant.

Since 1905 public school education has been available for some visually handicapped children. Through the years this education has progressed from provisions for segregated special classrooms or special day schools to integration of children in regular classes, with provisions for one of the above services. Jones and Collins (1966) defined five basic types of organizational patterns, including:

> Itinerant teacher—an organizational pattern whereby blind and/or partially seeing children spend most of their school day in regular classrooms but receive special instruction individually or in small groups from itinerant teachers who travel among two or more schools devoting more than half their time to the instruction of such children.
>
> Teacher consultant—an organizational pattern whereby special teachers serve as itinerant teachers part of the time but spend 50 percent or more of their time in more general duties, such as consulting with regular school personnel and distributing aids.[1]

Itinerant programs for visually handicapped children have grown rapidly during the last 25 years throughout the nation. In many cases the development has been the result of a long planning process by educators. Other programs have evolved because of the expressed desires of parents to keep their children in local schools. Presently, the programs operate in a unique fashion depending upon geography, population, administrative policy, and the teacher's own perception of his role.

Theoretically, the model implies that on the "island of regular education" on which the handicapped child resides for most of the school day, he or she is provided with educational experiences available to other children, including those designed to develop academic skills. The regular teacher accepts responsibility for academic instruction. The itinerant teacher's role is as advisor, helping with suggestions that will enable the regular teacher to meet the needs of the exceptional child and, coincidentally, better to meet the individual needs of each child in the classroom. Additional needs, specific to the exceptional child, such as language development for the deaf child and Braille or other tactual adaptations for the blind child, are met by direct instruction of the child by the itinerant teacher.

For the science teacher, this means that responsibility for instruction in science remains with the regular teacher. The itinerant teacher may best be regarded as an ally with complementary but not identical skills. The science teacher instructs both handicapped and nonhandicapped youngsters, while the itinerant teacher instructs in special skills which the exceptional child needs. At the same time, the itinerant teacher may be seen as a resource who can advise the science teacher and the student with respect to adaptations of teaching and learning techniques and assist in modifications or substitutions for materials used in science instruction.

The final effectiveness of this program depends upon each professional accepting his role and responsibilities, all working as a team for the benefit of the child, and the educational philosophy of this model being child-centered rather than teacher-centered. The development of an effective itinerant teaching program for exceptional children must be the result of a careful planning process by all educators, since the success of such a program will depend upon the close cooperation of local school personnel and special educators.—MARY W. MOORE, *Program in Special Education, University of Pittsburgh, Pittsburgh, PA 15260.*

[1] J. Jones and A. Collins, *Educational Programs for Visually Handicapped Children* (Washington, DC: U.S. Government Printing Office, 1966), pp. 6-7.

Aids in Teaching Laboratory Science to the Visually Impaired

No major changes are needed in the science curriculum or science laboratory for the visually impaired student. In the science laboratory some modified techniques, however, are necessary and closer peer interaction is required between the sighted and non-sighted students. Alternate techniques are necessary for the blind to do certain tasks, such as using the microscope. This article is not an attempt to be all inclusive, but rather to give examples of modifications. Many minor alterations can be done to make a unit of instruction accessible to the blind. These generally fall into four categories: equipment modification, modeling, labeling, and alternate or secondhand experience.

Examples of equipment modification include the use of a Braille ruler on the third beam of a centigram balance (the other two beams can be tactually "read" by the blind). A light sensor gives the approximate location of the needle on a pH meter. A plastic syringe notched at various units substitutes for a graduated cylinder for measuring liquids. For accuracy, liquids can be measured by weighing.

Raised line drawings on metal foil, Braille paper, or a cellulose sheet are some examples of modeling which substitute for ordinary drawings. Braille paintings in a shallow cardboard box or on plywood are more durable and can be more intricate than line drawings. Casein glue can be used for the tactile aspects of the models with textures and other lines made of additional glue, string, rope, silicone, tape, seeds, bits of wood, sand, rubber bands, and so on. The Braille painting can be made to represent live materials viewed in a microscope or binocular. The colloidal flow of cytoplasm in a protozoan can be shown by a jello amoeba. Bits of nuts, macaroni, and other foods can be the inclusion. A string and clothespin are used to shape the pseudopods and ice pads and hot pads applied to the underside simulate the sol-gel change. In chemistry, molecular arrangements can be made of Braille paintings. The American Printing House for the Blind has some excellent biologi-

cal models. Action models are excellent adjuncts to the basic program.

Braille labeling of chemicals, equipment, reagents, shelves, specimens, specimen containers, cabinets, faucets, dangerous materials, and instructions on use are very important and necessary for the safety and efficient operation of a science laboratory. For students who may not read Braille, differently shaped or textured labels may be used, while for those with partial sight, large-print labeling may be most appropriate.

Examples of alternate or second-hand modifications include the use of *Chlorella* grown on minimal medium to prevent the inclusion of pathogenic opportunists instead of bacteria in microbiological projects. The tracing of a kymograph can be photographically enlarged to be viewed by the visually impaired or marked with a tracing wheel for tactile observation by the blind. The path of this tracing, as well as that of an electrocardiograph can be read with an Optacon, by those who have this equipment.

Graphs, models, and alternate forms of presentation are all useful to the visually impaired student, and they also reinforce and can clarify the learning of the visual students. Thus, the needs of the blind student need not limit or interfere with the learning experience of sighted peers. Indeed, the techniques used may benefit all members of a class. With only a few modifications in laboratory techniques, and no changes in the curriculum, visually handicapped students can participate well enough to obtain a thorough understanding of the procedures and concepts of science.—DOROTHY TOMBAUGH, *Euclid High School, Euclid, Ohio 44123.*

Aids in Teaching Laboratory Science to Deaf Students

People might think that teaching the deaf student laboratory science would require an extensive array of nonconventional materials, techniques, and devices. In fact, only a few changes in conventional science teaching aids are required. Deaf and hearing-impaired students most certainly respond to the use of a variety of teaching aids and strategies, but this is true of hearing students as well.

If one were to examine closely a science classroom in a school for the deaf, it would probably not appear to be any different from a classroom or laboratory for hearing students. One might see a few more visual devices, more films, more filmstrips. One might also observe more labeling of materials and equipment. Computer terminals with visual simulation activities might be in evidence. But the ultimate conclusion would be that it is not very different from a regular classroom/laboratory for hearing students. The aids and materials for the use of the deaf are essentially the same as those for the nonhandicapped student.

Upon closer examination, however, you might detect that the written materials are at a lower level than you might have expected for the nonhandicapped student. This is true, and for those in science education there is a never-ending search for science materials that will challenge the competencies of deaf students but remain within their reading comprehension. The frequently lower reading level of the deaf student is a major problem for the science teacher of the deaf whether the teaching is done in an integrated program or in a school for the deaf.

Hands-on experience, utilizing visual, kinesthetic, and other sense modalities can be of significant value to the student with low-level reading skills. The principle of learning by doing is nowhere so true as in the teaching of science to deaf and hearing-impaired students. The use of visual media and hands-on activities can make science a rewarding learning experience for the student and a satisfying pedagogic experience for the teacher. They can provide for the needs of deaf or hearing-impaired students and, at the same time, enrich the education of hearing students.

A teacher who encounters a deaf student in a mainstreamed setting may wish to keep these things in mind.

1. Visual media are best used to help the deaf student (or other students with low reading levels, aside from those with impaired sight) move from the concrete into the abstract.

2. Experiments dependent on the auditory sense can often be performed using a visual mode. The Doppler effect can be demonstrated by a ripple tank as well as by a train whistle. A spring can demonstrate compressional waves, while other experiments with sound may utilize oscilloscopes or computer-generated sound spectrograms.

3. Some care should be taken in the use of chemicals and machinery with deaf students. This *not* to say that they cannot safely manipulate generators, burners, or caustic chemicals. They should, however, be carefully instructed in their use and ought to wear eye goggles—as should hearing students. In addition, they should be oriented carefully to safety equipment. It may be desirable to pair off a hearing-impaired student with a hearing "buddy" for purposes of alerting the former to any alarms or emergencies.[1]

4. Placement of a hearing-impaired student's work station should orient the student away from a window, to facilitate lipreading. You may wish to speak with the student about seating options or preferences.

5. Many deaf students use manual communication in the laboratory or classroom. A sign-language interpreter serves as a medium between the student and the teacher. Discussion should be directed to the student, not to the interpreter. This will give the teacher a better sense of direct contact with the signing student.

Deaf and hearing-impaired students can do well in science within the regular classroom with attention to some basic considerations and common sense. Few if any aids especially for deaf individuals will be required so long as there is a basic emphasis on hands-on experience and use of sensory modalities other than hearing, and the reading requirements relate to the capabilities

[1] Harry G. Lang, "Mainstreaming: A New Challenge in Science Education for the Deaf." *Midwest Education Review*, Spring 1978, pp. 22-23.

of the student—PAUL J. CUNNINGHAM, *Model Secondary School for the Deaf, Gallaudet College, Washington, D.C. 20002*, and HARRY G. LANG, *National Technical Institute for the Deaf, One Lomb Memorial Drive, Rochester, N.Y. 14623.*

Aids in Teaching Field Aspects of Science to the Physically Handicapped

Many handicapped students progress through their schooling and into careers without the benefit of field experience in science. Handicapped students have either taken courses or programs that avoid field work, have been excused from field work, or have had inadequate field experiences. Providing field experiences in science to physically handicapped students whether blind, deaf, or mobility limited is both possible and rewarding. Aids to the teaching of field science to the physically handicapped are in general inexpensive and simple.

The aids presented below are limited to the experience of the author, his readings, and his discussions with colleagues. In no way does this represent a full list of aids for field science, but rather it shows that the adjustments needed to take physically handicapped students to the field are not difficult, although prior planning is often necessary. Sometimes prior simulation of the field project or trip may be necessary.

To set the stage for this presentation, the following describes some findings about how handicapped students reacted to a summer field science experience with physically handicapped (mostly deaf, many blind, a few mobility limited, and one blind-mobility-impaired) precollege students in a marine science program at Wallops Island.[1,2,3] The participants and the faculty felt that the degree of learning was about the same for both the field and the laboratory aspects of the program and that it was somewhat higher than that achieved in the lecture portions of the course. Further, the students felt that the field experiences were somewhat less difficult than the laboratory or lecture sections and were considerably clearer (as determined from the academic scores).

The initial problem is to make the field experience accessible for the orthopedically handicapped. Physical access is then generally available and improved for *all* students.

Certain areas of the coastal environment such as the tidal flat or ephemeral ponds that were studied in the Wallops Island Marine Science Program were only marginally used by the orthopedically handicapped because of safety (for the students) reasons. These included actual seining in ephemeral ponds and the ocean and sampling of the "soft tidal flats." Orthopedically handicapped students were in those environments, but were not involved directly in sampling to the extent that the other students were. However, access for the wheelchair-using students to tidal flats and wet marsh (or bog) areas can be achieved with minimal environmental damage by the use of snow fencing. A sled instead of a wheelchair can be used in sandy areas. A four-wheel drive vehicle has been a useful facilitative adjunct for the program in marine science.[1] Temporary (and portable) ramps of 4′ x 8′ x ¾′ plywood were useful in improving access to the beach and dune areas, to the boats, to a museum, to a movie theater, and to other areas. Portable metal ramps and wheel tracks are commercially available. Brass ring tie-downs for the wheelchairs were very useful on the boats during transit. Buses can be equipped with these or other tie-downs. Portable sit-down height observation and equipment tables were useful in the field.

Blind students require a different set of facilitative activities and aids. A special orientation session for the blind on the equipment (Braille-labeled) that will be used in the field, along with a tactile map of the area and models of vehicles, boats, and other items, is extremely helpful. These sessions are best given prior to the regular description and equipment orientation sessions.

Prior familiarity with brailled herbarium collection samples, models, and thermoform materials of items expected in the biology, geology, or other field science exercises is very beneficial. Some of this material is available through the American Printing House for the Blind. Tape recording in the field is essential for recalling information and for subsequent use in the laboratory, classroom, or study periods. A focus on qualities of taste, form, texture, and smell associated with the field experience is not only extremely helpful to the blind, but adds a new dimension of learning to the sighted student. Finally, an instructor working with the blind must remember to give a detailed description of the items being discussed and handled.

The most prominent of the facilitative activities and aids needed by deaf students for field learning is interpretation. Many will even contend that the use of manual or oral communication is the only facilitative aid that the deaf need for field experiences. However, there are certain other activities that improve the transfer of information, such as the field use of flash cards to obtain simultaneously the written and object association rather than to go through signs. The emphasis on aspects of texture, taste, and smell in addition to sight is of great usefulness to deaf or hearing impaired, as well as to blind students.

Detailed verbal descriptions, which are desirable for the blind, are less desirable for the deaf students. There are few manual signs for scientific terms. This leads to emphasis on finger spelling, which reduces speed of communication. These problems can be alleviated by a special orientation session for the deaf to the field activities, in which they can read ahead about the activities to be covered. The only modifications suggested

[1] E. C. Keller, Jr., Final Report to NSF, "Student Science Training Program in Marine Science for the Handicapped," 1977.

[2] E. C. Keller, Jr., Final Report to NSF, "Student Science Training Program in Marine Science for the Handicapped." 1978.

[3] E. C. Keller, Jr., and Helen Keller, "Experiences with Multiple Types of Handicapped Precollege Students in an Integrated Marine Science Field Program," *Proceedings, Conference on Science Education for Handicapped Students*, National Science Teachers Association, 1978.

might be to ensure that the reading level of the materials corresponds to the reading level of the deaf students and that additional visual aids be used where appropriate. This is also of educational benefit to the other students.

Multiply handicapped individuals (orthopedic/deaf, blind/orthopedic, etc.) have received little attention in the science teaching community. Often it is assumed incorrectly that they are too severely disabled to participate. However, students with multiple physical handicaps generally need the same modifications as those with a single physical handicap. My own experience with multiple handicaps has been limited to work with one orthopedic-blind person. All of the modifications made in the program for the other orthopedic or blind individuals were satisfactory for this student.

Finally, from the experiences of the Wallops Island Program in Marine Science for the Physically Handicapped, it was extremely beneficial for the students and staff to spend the first few days in what was called a communications laboratory or workshop, where blind students learned tactile finger spelling, deaf students learned to visually recognize Braille alphabet, and the orthopedically handicapped and the staff (one of whom was handicapped) learned both. Exercises and games were devised using parts of all of the communications systems (auditory, tactile, and visual). Not only was this activity extremely worthwhile in helping the students to get to know one another, but it was of great use in promoting cooperation between the deaf and blind students throughout the program. The buddy system of mixing handicapped and nonhandicapped students is very useful and helpful to the teacher as well as the students.

Field experience for physically handicapped students in earth, ecological, engineering, environmental, and other sciences is a reality. Providing field experiences for handicapped students does not increase costs very much, but it does require good planning, contingency plans, and some pre-field-experience simulation. The scale of the efforts required will, of course, be smaller where only one or two handicapped students are involved. The Wallops Island Program demonstrated the feasibility of providing field experiences for a large group of handicapped students. Further, it provided much understanding of the types of accommodations needed. The kinds of preparations other teachers may need will be similar, but the specific accommodations to be made are, in the end, dependent on the individual needs of the handicapped students in a class.—E. C. KELLER, JR., *Department of Biology, West Virginia University, Morgantown, WV 26506.*

Counseling of the Handicapped for a Scientific Career: A Lifestyle Approach

Dealing with handicapped persons as a stereotyped population is meaningless and sometimes risky. The handicapped population is as heterogeneous as the able-bodied population. All human conditions, personalities, and lifestyles are to be found within the population we call "handicapped." The temptation to stereotype such a diverse population is great. If we recruit, employ, counsel, or entice handicapped persons into scientific careers to the exclusion of other types of careers, we may commit a gross error. Many handicapped persons—like the nonhandicapped—do not possess the abilities, interests, or lifestyles conducive to receiving satisfaction from scientific occupations. Our task with handicapped individuals, then, is the same as with the able-bodied. From the population we must identify individuals whose lifestyles are compatible with scientific careers and provide them with every opportunity for education and gainful employment in one of those careers.

Whether or not to encourage handicapped persons to enter scientific careers does not appear to be the relevant issue. Most of us are in agreement that this is necessary. The question is how should we proceed? It would be best to focus attention, time, energy, and money on procedures and processes that will accurately identify handicapped individuals who are well suited for scientific careers and then to offer them economic and psychological encouragement to pursue training for and entry into scientific occupations. We should work intensely with individuals, as opposed to mass populations. To work with the handicapped population as individuals will indeed be a difficult and complex venture; yet, the dividends may well be worth the investment.

Vic Maguran, Director of Career Opportunities at the National Technical Institute for the Deaf (NTID), has described the individual approach used at NTID. It is not uncommon for several staff members there to work with a single student on personal problems, occupational identification, skill development, and placement. Mr. Maguran admits that this is a costly procedure but explains that 97 percent of all graduates from NTID find employment and that 95 percent of them find employment in their preferred occupation. These are handicapped individuals who are finding their place in scientific and technical careers.

In our efforts to recruit handicapped persons into scientific careers, we should avoid the temptation to take short-cuts. Instead, we should work diligently at developing methods for working with individuals within their lifestyles and their general interests. One method of approach is the "lifestyle approach" which first identifies life themes, or values and decision-making styles. Then a wide variety of occupations that fit the lifestyle are explored and eventually reduced to one or two. Finally, educational programs are explored to determine which one will best fit the individual as well as the occupational choice.

Life Career Assessment

The first step in the life career exploration is a procedure called "life career assessment." The purpose of this assessment is to identify basic life themes (perhaps life goals or basic life values would be better descriptors). The technique used is relatively simple. Some structured questions about the person's past occupational, educational, and recreational-leisure experiences are asked. Questions are then asked about their typical

day and their strengths and weaknesses. As a result of this questioning, common themes appear over and over again in a given individual. Some examples of lifestyle themes are discovery, independent work (working alone), a need for structured activities, distant supervision, team work, or variety. A lifestyle theme cuts across all aspects of a person's life and, in the process of asking the questions, individuals become fully aware of their unique lifestyle themes.

During the assessment, the individual's preferred decision-making style is also determined. One style is no better than the other, but it is important for individuals to maximize the use of their preferred style. Helping individuals identify their natural style of decision making greatly aids the exploration process.

Occupational Exploration

During the occupational exploration phase, students are exposed to a large number of occupations through literature, cassette tapes, or interest tests and are asked to select any occupations that appear to satisfy their basic lifestyle themes. At this point, handicapped persons are directed to ignore their handicap in their selection of occupations. This is not the time to attempt to be realistic. If individuals are pushed to be "realistic" at this point, they are apt to miss a large number of occupations, for lack of information, that may, indeed, be quite feasible—particularly occupations in the scientific area, since scientific careers tend to be "feared" and misunderstood most. After the initial list has been prepared, a discussion, rank ordering, and gathering of more specific data about the selections are done until the choices can be narrowed to one or two that are realistic and satisfying to the individual.

Educational Exploration

The purpose of this last phase is to help students identify a discipline that will eventually lead them to their occupational goal. They are given literature or cassette tapes that describe the various majors that are available. Once again, they are asked to select several educational programs that will provide them with training for their occupational choice. Then they make contact with faculty advisors, department chairpersons, and other faculty from each of the majors to help them determine which one will suit them best. This phase typically requires two sessions.

When the "life career exploration" is completed, individuals not only have an occupational direction, but an educational direction as well. Even more important, individuals have a commitment to that goal because they have made the selection themselves. Through the exploration process, handicapped individuals can come to know some of the employment difficulties they will face immediately. Individuals with life themes of discovery, learning, or curiosity, along with decision-making styles that are largely systematic and internal tend to be good candidates for scientific careers. Backgrounds, aptitudes, and interests in mathematics and science courses through junior high and high school give even more credence to the choice of a scientific career.—This article is based on a presentation at the 1978 AAAS annual meeting by the late RICHARD U. JOHNSON, Southern Illinois University, Carbondale.

Careers in Science for Handicapped Persons

The physically impaired have been underprepared for entry into the study of science and, as a result, underemployed in the scientific professions. A specific lack of career information and guidance materials exists. The long-term net effect of these deficiencies has been to deprive physically handicapped persons of opportunities to make contributions to science and to deprive the country of the talents and resources of intelligent and capable men and women.

A physically handicapped individual must be able to investigate all science-related occupations. This can be achieved by using media presentations compatible with the handicap, such as filmstrip, printed matter, Braille, audio-tape, microfiche, and so on. With the guidance of a teacher or counselor it is then the responsibility of the handicapped user of the information to make his or her own career decisions. This approach respects the autonomy of handicapped individuals and their capacity to make decisions affecting their lives.

Science career briefs are now available through the project on Science Career Information for the Physically Handicapped Individual (SCI-PHI) for 228 science-related occupations. The briefs present nineteen on-the-job physically related tasks indicating the approximate amount of time each task takes for the 228 occupations. Physically handicapped students can use briefs in mak-

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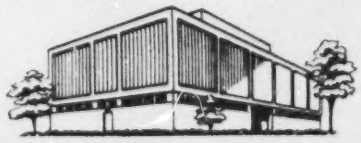

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ing decisions concerning the implications of their handicaps for their career choices. It is suggested by the briefs that no single science-related task, no matter how impossible to overcome it might seem at the moment, should keep a person from pursuing a specific occupation. It is indicated that the major barrier that a physically handicapped person faces in achieving a science career is not the handicap. Rather, the barriers are primarily attitudinal and include the stereotypes and expectations held by the teachers, counselors, and employers of physically handicapped persons. With the current focus on increasing the participation of the handicapped in science (other than career information materials) society must change the long-held, erroneous, negative opinions about the handicapped and their interest and capabilities in science.

It is our hope that SCI-PHI will come to mean "Science Fact—Not Science Fiction" in terms of science occupations for the physically handicapped. In order to accomplish this goal, it is the responsibility of science educators and counselors to provide sound career information for the handicapped.—NEAL BERGER and JOHN R. CLARK, *SCI-PHI Project, Thomas County Schools, Thomasville, GA 31792.*

Resources

The following collection of addresses of organizations and sources of information that may be helpful to teachers who have handicapped students in their classes was compiled by CHERYL DAVIS, *Program Associate, AAAS Office of Opportunities in Science.*

American Foundation for the Blind, Inc., 15 West 16th St., New York, NY 10011 (212) 924-0420. Promotes the development of educational, rehabilitation, and other services for children and adults. Books and periodicals in printed, recorded, and Braille forms, special aids and appliances, information on visual impairments.

American Printing House for the Blind, Inc., 1839 Frankfort Ave., Louisville, KY 40206 (502) 895-2405. Textbooks and aids for students and/or special schools at elementary and secondary levels. Braille books, magazines, and music; large-type texts; recordings. Aids useful for science areas, including maps, drawing and graph materials, and suggestions for educational procedures and methods.

Science for the Blind, Inc., Box 120, Bala-Cynwyd, PA 19004 (215) 664-9429. Puzzles, games, construction kits, low vision aids, and devices useful in teaching science and technical procedures. Some represent adaptations which may be easily improvised; others are more specialized.

National Technical Institute for the Deaf, One Lomb Memorial Drive, Rochester, NY 14623 (716) 475-6400. A post-secondary technical school for deaf persons, with programs leading to the following degrees: A.A., B.S., M.S., B.Tech., M.S.T., and others.

Registry of Interpreters for the Deaf, P.O. Box 1339, Washington, DC 20013. Distributes a directory of membership and provides information on interpreting services.

Some Organizations of and for the Handicapped

Alexander Graham Bell Association for the Deaf, 3417 Volta Place, N.W., Washington, DC 20007.

American Coalition of Citizens with Disabilities, 1346 Connecticut Ave., N.W., Rm. 817, Washington, DC 20036.

American Council of the Blind, 1211 Connecticut Ave., N.W., Rm. 506, Washington, DC 20036.

Epilepsy Foundation of America, 1828 L St., N.W., Washington, DC 20036.

National Association of the Deaf, 814 Thayer Ave., Silver Spring, MD 20910.

National Federation of the Blind, 1346 Connecticut Ave., N.W., Suite 212, Washington, DC 20036.

Spina Bifida Association of America, P.O. Box 5568, Madison, WI 53705.

United Cerebral Palsy Association, 66 E. 34th St., New York, NY 10016.

Selected Publications of Organizations of and for Handicapped Persons

Accent on Living, P.O. Box 700, Gillum Road and High Drive, Bloomington, IL 61701.

Amicus, National Center for Law and the Handicapped, 1235 N. Eddy St., South Bend, IN 46617.

Closer Look, National Information Center for the Handicapped, Box 1492, Washington, DC 20013.

Directory of Organizations Interested in the Handicapped, Committee for the Handicapped, People-to-People Program, 1028 Connecticut Ave., N.W., Rm. 610, Washington, DC 20036.

Disabled USA, President's Committee on Employment of the Handicapped, Washington, DC 20210.

The Exceptional Parent, 20 Providence St., Rm. 708, Boston, MA 02116.

Muscular Dystrophy News, MD Association of America, Inc., 810 Seventh Ave., New York, NY 10019.

Selected Bibliography

The publications listed below are taken in large part from a bibliography compiled for the Science for the Handicapped Association by Kenneth Ricker, Department of Science Education, University of Georgia.

General Interest

American Association for the Advancement of Science. *Access to Science* (newsletter). Washington, DC: AAAS.

Brown, Janet Welsh. "Who Are the Handicapped Scientists?" *Science*, 7 November 1975, pp. 546, 593.

Biological Sciences Curriculum Study. *BSCS Newsletter.* Nos. 36, 38, 43, 44, 46, 48, 52, 53, 55, and 56. Boulder, CO: BSCS.

Davis, Cheryl and Redden, Martha. "Achievement in Biology: An Introduction to Handicapped Biologists." *American Biology Teacher*, March 1978.

Hadary, Doris. "Picking Up Good Vibrations from Science for the Handicapped." *Science Teacher*, December 1975, pp. 12-13.

Hadary, D. and Cohen, S. "Laboratory Science and Art for Blind, Deaf, and Emotionally Disturbed Children—A Mainstreaming Approach" (films, slide presentation, and resource book). Baltimore, MD: University Park Press, 1978.

Hillam, Bruce P. "You Gave Us Your Dimes . . ." *Newsweek*, 1 November 1976, p. 19.

Hofman, Helenmarie, ed. *A Working Conference on Science Education for Handicapped Students: Proceedings.* Washington, DC: National Science Teachers Association, 1978.

Proscia, Vito; Stearner, Phyllis; Keller, E. C., Jr.; and Ballantyne, Donald L. "A Challenge to Teachers from Handicapped Scientists." *Science and Children*, March 1976, pp. 15-16.

Redden, Martha Ross. "Handicapped Resource Group Members Work for Barrier Elimination." *Science*, 4 February 1977.

Redden, Martha Ross, and Brown, Janet Welsh. "Expanding Horizons: Careers in Science." *Rehabilitation Counseling Bulletin.* June 1976.

Redden, Martha Ross; Brown, Janet Welsh; and Fortunato-Schwandt, Wayne. *Barrier Free Meetings: A Guide for Professional Associations.* Washington, DC: American Association for the Advancement of Science, 1976.

Redden, Martha Ross, and Schwandt, Wayne. *Science, Technology and the Handicapped, Proceedings of a Symposium.* Washington, DC: American Association for the Advancement of Science, 1976.

Redden, Martha Ross; Maker, June; and Tonelson. Steven. *Coping Strategies of Successful Disabled Scientists.* Washington, DC: American Association for the Advancement of Science, 1978.

Redden, Martha Ross, and Malcom, Shirley Mahaley. "A Move Toward the Mainstream." *Science and Children,* March 1976, pp. 14-16.

Ricker, Kenneth S. "Providing Unhandicapped Teachers for Handicapped Pupils: A Preservice Science Education Course for Special Education Teachers." Paper presented at National Science Teachers Association Convention, March 1977, Cincinnati, Ohio.

Science Curriculum Improvement Study. *SCIS Newsletter.* Nos. 22, 23, and 24. Berkeley, CA: SCIS.

Task Force on Public Awareness and the Rights of Disabled People. *Your Responsibilities to Disabled Persons as a School or College Administrator.* Washington, DC: U.S. Department of Health, Education and Welfare.

Blindness and Visual Impairment

Boyle, J., et al. "A Braille Code for Interactive Terminal Use." *American Foundation for the Blind Research Bulletin,* April 1974, pp. 267-72.

Brower, Kenneth. "On the Reef Darkly." *Atlantic,* November 1976, pp. 94-102.

Cranmer, T. V. "Liquid Level Indicator for the Blind: Electronic Device." *Popular Electronics,* May 1967, pp. 59-60.

Evans, Q. "A Simple Capacitance Bridge." *Braille Technical Press,* November 1958.

Francouer, Pearl and Belhah, Eilam. "Teaching the Mammalian Heart to the Visually Handicapped: A Lesson in Concrete Experience." *Science Teacher,* December 1975, pp. 8-11.

Franks, Frank L. "Educational Materials Development in Primary Science: An Introductory Science Laboratory for Young Blind Students." *Education of the Visually Handicapped,* December 1975, pp. 97-101.

Franks, F. L. "Measurement in Science for Blind Students." *Teaching Exceptional Children* 3 (1970):2-11.

Franks, F. L. et al. "Biological Models Project." Unpublished report, American Printing House for the Blind, 1973.

Franks, F. L. and Nolan, C. Y. "Measuring Geographical Concept Attainment in Visually Handicapped Students." *Education of the Visually Handicapped* 3 (1971):11-17.

Fulker, Wilber H. and Fulker, Mary. *Techniques with Tangibles.* Springfield, IL: Charles C. Thomas Publisher, 1968.

Gunderson, R. "Reading Visual Meter Movements by the Voltage Comparison Method." *Braille Technical Press,* December 1958.

Hiemenz, Paul C. and Pfeiffer, Elizabeth. "A General Chemistry Experiment for the Blind." *Journal of Chemical Education,* April 1972, pp. 263-65.

Lennon, Elizabeth M.; Feirer, J. L.; and Purdy, W. K. "Metrics for Visually Impaired Persons." *New Outlook for the Blind,* January 1976, pp. 1-4.

Linn, Marcia and Thier, H. "Adapting Science Materials for the Blind: Expectation for Student Outcomes." *Science Education,* April/June 1975, pp. 237-46.

Loomis, Madeleine S. and Mitchell, P. C. "Braille Chemical Notations and How to Use Them." *Monograph* No. 8. New York: The New York Institute for the Education of the Blind, 1939.

Mallinson, George C. and Mallinson, J. V. "Symbolic Science Learning for the Blind." *School Science and Mathematics,* May 1967, pp. 432-49.

Nolan, C. Y. and Morris, J. E. "Japanese Abacus as a Computation Aid for the Blind." *Exceptional Child,* September 1964.

Redden, Martha Ross and Davis, Cheryl. "Mainstreaming, the Kurzweil Reading Machine and Science Education for the Handicapped." *The Kurzweil Reading Machine.* Boston: Exceptional Parent (in press).

Science Activities for Visually Impaired. *SAVI Newsletter,* No. 1, February 1977. Berkeley, CA: SAVI.

Science Curriculum Improvement Study. *SCIS Newsletter,* Summer 1969, Spring 1971.

Thomas, Barry. "Environment Education for the Blind." Instructor, May 1977, pp. 136-7.

Tombaugh, E. Dorothy, *Biology for the Blind.* Euclid, OH: Euclid Public Schools, 1973.

Tombaugh, Dorothy, "Laboratory Techniques for the Blind." *American Biology Teacher,* May 1972, pp. 258-60.

Weems, Bruce. "A Physical Science Course for the Visually Impaired." *Physics Teacher,* September 1977, pp. 333-38.

Wexler, A. *Experimental Science for the Blind.* London: Pergamon Press, 1963.

Wexler, A. *Experimental Science for the Blind: An Instructional Manual.* London: Pergamon Press, 1961.

Willoughby, Doris et al. *Your School Includes a Blind Student.* Washington, DC: National Federation of the Blind, 1977.

Deafness and Hearing Impairment

Bybee, R. W. "A Review of Literature of Science for the Deaf." *Science Education,* April/June 1972, pp. 237-42.

Catalog of Captioned Film. Washington, DC: National Information Center for Educational Media, Bureau of Education for the Handicapped, U.S. Department of Health, Education and Welfare.

Clarcq, Jack et al. "Career Development and Media Utilization at the National Technical Institute for the Deaf." *American Annals of the Deaf,* October 1973.

Egelston, Judy C., and Mercaldo, David. "Science Education for the Handicapped: Implementation for the Hearing Impaired." *Science Education,* April/June 1975, pp. 257-61.

Lang, Harry G. "Mainstreaming: A New Dimension in Science Education for the Deaf." Unpublished seminar research paper, National Technical Institute for the Deaf, 1977.

Lang, Harry G. "Teaching Physics to the Deaf." *Physics Teacher,* December 1973, pp. 527-31.

Research for Better Schools. *Is Science a Possible Career for You?* (Teacher/counselor guide and captioned filmstrip.) Philadelphia, PA: Research for Better Schools, Inc., 1978.

Shultz, Ora Ann. "Planetarium Astronomy for the Hearing Impaired." *Science Teacher,* April 1973, pp. 45-46.

Yonovitz, A. "Amateur Radio for the Deaf." *Volta Review,* May 1969, p. 259.

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